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THE FRANKFORT CRANIOMETRIC AGREEMENT,

WITH CRITICAL REMARKS THEREON.

BY

J. G. GARSON, M.D., F.Z.S.,
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[WITH PLATES VIII AND IX.]

FOR some time past anthropologists in Germany have been laudably endeavouring to come to a general agreement among themselves as to a method of measuring skulls which would be generally adopted. For this purpose a Craniometric Conference was held at Munich in 1877, and another in Berlin in 1880. The outcome of the deliberations of these conferences was a scheme drawn up by Professors Kollmann, Ranke, and Virchow, which was submitted for consideration to the 13th General Congress of the German Anthropological Society, held at Frankfort-on-Maine in 1882. The scheme was adopted and designated the "Frankfort Agreement," of which the following is a more or less literal translation.

The Horizontal Plane of the Skull.

The German horizontal plane, as accepted by the Craniometric Conferences held at Munich and Berlin, is defined as follows :—"That plane which is determined by two straight lines (one on either side of the skull), connecting the lowest points on the inferior margins of the orbits with the points of the upper margins of the bony auditory meatus situated vertically above their centres" (Plate VIII, figs. 1 and 2, *hh*). In relation to this German horizontal plane is measured the direct length of the cranium, the height, the maximum breadth, the breadth of the forehead, and other cranial measurements; likewise the angle of inclination of the foramen magnum, the profile angle of the face, and several other facial measurements to be enumerated and described further on.

The Craniometric Conferences mentioned have also decided to accept a number of other measurements, which are independent of the horizontal plane of the skull, so that numerous and valuable older measurements which have not been made in relation to "our horizontal plane," and therefore not exactly comparable to it, be not rendered valueless; and secondly, for the important reason that in broken skulls in which the facial region is wanting, as is frequently the case among the most important prehistoric skulls, an exact determination of the German horizontal plane is impossible. In these cases it is decidedly preferable to select fixed anatomical points on the skull, as starting-points for the principal measurements, instead of making uncertain subjective estimates of the probable situation of the plane and of the measurements in relation to it. By the use of these points it is possible to make measurements taken without reference to the German horizontal plane accord with those made in reference to that plane.

The necessity for auxiliary measurements independent of the German horizontal plane, was expressly recognised by both Craniometric Conferences for determining the length of the skull. For measuring the height of the skull the same need is obvious; likewise an auxiliary measurement which, though placed at some distance from the base of the skull, is often indispensable to determine the breadth of the cranium.

The auxiliary measurements of length have already been determined upon by both Conferences. They are the maximum length, and that length "the anterior measuring point of which is situated in the middle of a straight line uniting the centres of the frontal eminences." This latter length-measurement seems to be indispensable for comparing the length of the skull proper of the Anthropoidea with that of man. Both lengths are measured with the callipers.

In the following list the names of the most important measurements of the skull are given, and short descriptions of the methods of ascertaining each. These will be rendered still clearer by the accompanying illustrations (Plates VIII, IX).

Linear Measurements of the Cranium.

1. *Horizontal length* (*gerade Länge*).—From the middle point between superciliary ridges on the glabella to the most prominent point of the back of the cranium (Plate VIII, figs. 1 and 2), measured parallel to the horizontal plane of the skull with the sliding compasses (*Schiebezirkel*). This measurement of length was agreed upon at the Craniological Conference at Berlin. In cases where the glabella is greatly developed it is desirable, when possible, to measure its thickness.

[To this measurement is appended a note pointing out the necessity of its being always made with the sliding compasses (*Schiebezirkel*), or with Spengel's craniometer, and not with the callipers; because in skulls in which the occiput is very prominent at its lower part, the posterior point on the skull of the horizontal length line will not be so far back as the point at which that line, if prolonged backwards, would intersect a tangent line drawn at right angles to the horizontal plane, and touching the most prominent point of the occiput, fig. 2. In such a case the horizontal length indicated is too short, and must be prolonged to the tangential line of the most prominent part of the occiput. This can only be done with the two first-mentioned instruments. However, even with these practice and repeated control are necessary. In skulls with full and rounded occiputs this is not a difficult measurement to make, since the most anterior and posterior points lie on the same level. Regarding the anterior point on the glabella, a mistake is unlikely to occur. The measuring instrument is always placed in the median line, and between the superciliary ridges when these are separated].

2. *The maximum length.*—From the centre between the arcûs superciliaries to the most prominent point on the back of the head, measured with the callipers without reference to the horizontal plane.

[To this a notē is attached to the effect that it is only in skulls where the occiput is elongated posteriorly that a difference, which may be as much as 5 mm., occurs between this and the former length-measurement. When the occiput is full and rounded the horizontal and maximum lengths are identical, and when accurately measured the sliding compasses and callipers give the same results.]

3. *Intertuberal length.*—From the centre between the two frontal eminences to the most prominent point of the back of the head, without reference to the horizontal plane. Measured with the callipers.

Note.—The intertuberal length in brachycephalic skulls with good rounded foreheads coincides very nearly with the maximum and horizontal lengths.

4. *Maximum breadth* (fig. 4, B—B).—Measured vertically to the median plane with the sliding compasses wherever it is only not on the mastoid processes or on the posterior temporal ridges. The points of measurement must lie on the same horizontal plane.

4*a*. *Auricular breadth of Virchow.*—The distance between the two upper borders of the auditory meatus.

5. *Minimum frontal breadth.*—The shortest distance between the frontal ridges near their base, measured with the sliding compasses or callipers (fig. 3, SS).

6. *Height.*—The so-called total height (*ganze Höhe*) of Virchow From the centre of the anterior border of the foramen magnum to the parietal curve, measured vertically to the horizontal plane with the callipers (fig. 1, H). The difference in height of the anterior and posterior borders of the *foramen magnum* will thereby be indicated, by which the Baer-Ecker height is determined.

7. *Auxiliary height.*—In broken skulls, as already stated, where the facial portion is wanting, the horizontal plane cannot be determined. As an auxiliary height which approaches very nearly to the total height, the height from the centre of the anterior border of the *foramen magnum* to the point at which the sagittal and coronal sutures meet (*Bregma* of Broca) should be measured with the callipers.

8. *Ear-height.*—From the upper border of the auditory meatus to the point of the vertex of the head situated perpendicularly above it, measured vertically in relation to the horizontal plane of the skull (fig. 2, OH). Sliding compasses.

9. *Auxiliary ear-height.*—From the same starting-point to the highest point of the parietal curve, about 2—3 cm. behind the coronal suture. Sliding compasses.

10. *Length of the base of the skull.*—From the middle of the anterior border of the foramen magnum to the middle of the naso-frontal suture. Callipers.

11. *Length of the basilar portion.*—To the spheno-occipital suture (starting-point as in No. 10).

12 and 13. *Greatest length and breadth of the foramen magnum.* —Measured in the median plane and transversely to it.

13*a*. *Breadth of the skull-base.*—Distance between the summits of the mastoid processes.

13*b*. *Breadth of the base of the skull.*—Distance between the most prominent points on the outer surfaces of the mastoid processes.

14. *Horizontal circumference of the skull.*—Measured with the

steel tape placed immediately above the superciliary ridges and over the most prominent point on the back of the head.

15. *Sagittal circumference of the skull.*—From the naso-frontal suture to the posterior border of the foramen magnum along the sagittal suture. Steel tape.

16. *Vertical transverse circumference of the skull.*—From the upper border of the one auditory meatus to that of the other, perpendicularly to the horizontal plane (2—3 cm. behind the coronal suture. Steel tape. (N.B.—Virchow till now measures No. 16 over the bregma.)

Measurements of the Face.

17. *Breadth of the face, of Virchow.*—Distance between the two jugo-maxillary sutures. The measurement must be made from the under and anterior point of the one suture to the corresponding point of the other.

17*a* and *b*. *Breadth of the face, of Von Hoelder.*—(*a*) Distance between the two inner angles of the malar bones. (*b*) The distance between two points situated vertically below the apices of the inner angles of the malars on their under borders.

18. *Bi-zygomatic breadth.*—Greatest distance of the zygomatic arches from one another (fig. 4, JB).

18*a*. *Interorbital breadth.*—Minimum distance between the inner borders of the entrance of the orbital cavities.

19. *Height of face* (fig. 2, GH).—From the middle of the fronto-nasal suture to the middle of the under border of the mandible.

20. *Upper (= middle) face-height.*—From the middle of the fronto-nasal suture to the middle of the alveolar border of the upper jaw, between the central incisor teeth (fig. 2, W—OK).

21. *Height of nose.*—From the middle of the fronto-nasal suture to the middle of the upper surface of the nasal spine, *i.e.* to the lowest border of the pyriform opening (fig. 2, W—NL).

22. *Maximum breadth of the nasal cavity.*—Wherever that may be measured horizontally (fig. 3, X).

23. *Maximum breadth of the entrance of the orbital cavity.*—From the centre of the median border of the orbital cavity to its lateral border, that is, the clear space between the two borders of the orbital cavity (fig. 3, *a*).

24. *Maximum horizontal breadth of the entrance of the orbital cavity of Virchow* (fig. 3, *c*).—Measured parallel to the horizontal plane, otherwise analogous to No. 23. It is very desirable to determine the angle which the lines Nos. 23 and 24 (fig. 3, *a* and *c*) make with one another.

25. *Maximum height of the orbital cavity.*—Measured verti-

cally to the greatest breadth between the upper and lower borders (fig. 3, *b*).

26. *Vertical height of the orbital cavity.*—Measured vertically to No. 24 (fig. 3, *d*), otherwise analogous to No. 25.

27. *Length of the palate.*—From the point of the palatal spine to the inner lamina of the alveolar border between the central incisor teeth.

28. *Middle palatal breadth.*—Measured between the inner alveolar walls opposite the second molar teeth.

29. *Posterior palatal breadth.*—Measured at the posterior ends of the palate—*i.e.*, between their inner alveolar borders.

30. *Length of the profile of the face* (Kollmann's *facial length*) (fig. 2, GL).—Measured from the most prominent point of the centre of the outer alveolar border of the upper jaw to the anterior border of the foramen magnum (in the median plane).

31. *Profile angle.*—That angle which the profile line makes with the horizontal (fig. 1, $< hPf$). The measurement of other angles of the face and cranium remains still to be determined.

Measurement of the Capacity of the Skull.

32. The capacity of the skull is measured with shot (in fragile skulls with millet seed). The method to be followed remains for future consideration.

SKULL INDICES.

Length and Breadth Index.

$$\frac{100 \times \text{breadth}}{\text{length}}.$$

Dolichocephalic (long skull)	below 75·0
Mesocephalic	75·1 to 79·9
Brachycephalic (short skull) ..	80·0 „ 85·0
Hyperbrachycephalic	85·1 and over.

Length and Height Index.

$$\frac{100 \times \text{height}}{\text{length}}.$$

Chamæcephalic (flat skull) ..	75·0 and under
Orthocephalic	70·1 to 75·0
Hypsicephalic (high skull) ..	75·1 and over

Profile Angle.

The inclination of the profile line to the horizontal plane is classified under the three following divisions:—

1. Prognathous	82° and under.
2. Mesognathous or orthognathous	83° to 90°
3. Hyperorthognathous ..	91° and over.

Facial Index (Virchow).

$$\frac{100 \times \text{height}}{\text{length}}.$$

The breadth of the face considered as the linear distance between the two jugo-maxillary sutures. The facial height No. 19. (So also the facial index of Von Hölder).

Broad-faced skull	90·0 and under.
Narrow-faced skull	90·1 and over.

Index of the Upper Face (Virchow).

$$\frac{100 \times \text{upper facial height}}{\text{facial breadth}}.$$

Facial breadth considered as the linear distance between the two jugo-maxillary sutures, and the upper facial height (No 20) as above.

Broad upper face index ..	50·0 and under.
Narrow upper face index ..	50·1 and over.

Zygomatic Facial Index (Kollmann).

$$\frac{100 \times \text{facial height}}{\text{zygomatic breadth}}.$$

The greatest distance between the zygomatic arches (No. 18) and the facial height (No. 19). Divided into two classes—

Low-faced, chamæprosopic[1] skull ..	90·0 and under.
High-faced, leptoprosopic skull ..	90·1 and over.

Zygomatic Upper Facial Index (Kollmann).

$$\frac{100 \times \text{upper facial breadth}}{\text{zygomatic breadth}}.$$

Chamæprosopic upper face with an index of	50·0 and under
Leptoprosopic upper face with an index of ..	50·1 and over.

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[1] προσωπον, the face.

The upper facial index acts as a control measurement to the facial index. It is important to ascertain it in cases where, through absence of the lower jaw, the facial index cannot be determined.

Orbital Index.

$$\frac{100 \times \text{orbital height}}{\text{orbital breadth}}.$$

Chamækonchous	80·0 and under.
Mesokonchous	80·1 to 85·0
Hypsikonchous	85·1 and over.

Nasal Index.

$$\frac{100 \times \text{nasal breadth}}{\text{nasal height}}.$$

Leptorhine	47·0 and under.
Mesorhine..	47·1 to 51·0
Platyrhine	51·1 „ 58·0
Hyperplatyrhine	58·1 and over.

Palatal Index (Virchow).*

$$\frac{100 \times \text{palatal breadth}}{\text{palatal length}}.$$

Leptostaphyline	80·0 and under.
Mesostaphyline	80·1 to 85·0
Brachystaphyline..	85·1 and over.

The divisions of the indices marked * are provisional; their ultimate determination remains for future consideration.

The following table of the most important measurements and indices of the skull is then added.

Principal Measurements and Indices of the Skull.

CRANIAL PORTION.

No. of Skull.	Origin, Sex, Age.	Capacity.	Length.	Breadth.	Frontal Breadth.	Height.	Ear-Height.	Length of the Base of the Skull.	Horizontal Circumference.	Sagittal Circumference.	Transverse Vertical Circumference.
...	...	Cap.	L.	B.	B^1.	H.	E.H.	L.B.	H.C.	S.C.	T.C.

FACIAL PORTION.

Facial Height.	Upper Facial Height.	Facial Breadth.	Zygomatic Breadth.	Nasal.		Orbital.		Palatal.		Profile Angle.
				Height.	Breadth.	Breadth.	Height.	Length.	Breadth.	
F.H.	F^1.H.	F.B.	Z.	N.H.	N.B.	O_1.	O_2.	P_1.	P_2.	P>.

INDEX.

Length-Breadth.	Length-Height.	Breadth-Height.	Facial.	Upper Facial.	Nasal.	Orbital.	Palatal.	Remarks.
L.B.	L.H.	B.H.	F.H., F.B.	F^1.H., F.B.	N.H., N.B.	O_1.O_2.	P^1. P_2.	

Sixty-seven signatures of adherence are appended to the Agreement, among which are the names of several well-known anthropologists of Germany. Two signatures, those of Professors Aeby and Schaaffhausen, have riders attached to them. Professor Aeby adds that though he has signed the convention he nevertheless adheres to the fundamental principles expressed in his former works. Professor Schaaffhausen adheres to the Agreement on condition that an improper value be not set on the natural horizontal of the skull, which he has hitherto fixed as a line passing forwards through the centre of the auditory meatus, and cutting the profile line at a fixed point. For uniformity he is willing to take this line from the upper border of the meatus.

Before criticising the so-called German horizontal plane I must remark that it has hitherto been customary to consider those devoting themselves to any branch of science as belonging to one brotherhood, totally irrespective of the country to which they happen to belong, and beyond all national prejudices, with one common aim, namely, that of advancing the department to which they are giving their attention. That anthropologists in Germany should introduce the use of such terms as "German" and "our" to craniometrical questions is much to be regretted, as tending to destroy that feeling of unity which has always existed among scientific men. Nor are the terms alluded to the only exception that can be taken to the Frankfort Agreement. It seems to have been drawn up with little consideration of what has been done by other anthropologists over the world, save that of a few in Germany. Important measurements, which yield marked results in comparing skulls of different races, are entirely ignored, and methods of measuring accepted by anthropologists generally are altered without any reason being given for the change. The accuracy of these observations I now make will be apparent to any one acquainted with the literature of physical anthropology and the systems usually employed.

In drawing up any code of craniometrical measurements the extensive researches of Broca must be taken as the basis, this being the system which has been adopted by anthropologists generally over the whole world.

The horizontal plane adopted by the Frankfort Agreement is one which, in a slightly different form, has been before anthropologists for some time, having been originally proposed by the Russian craniologist, Von Baer, who placed the horizontal plane of the skull along the line of the zygomatic arches. Von Ihering modified, or rather defined, this plane more precisely as a line drawn from the centre of each auditory meatus to the lowest point on the inferior margin of each orbit. By the Frankfort Agreement the plane has been further modified by making the horizontal lines pass from the upper borders of the meatus to the lowest borders of the orbits. In none of its modifications has it been accepted by any except some German anthropologists, and not by all of them even yet. The question, which plane is the skull to be placed in for purposes of drawing and comparing drawings? has been for a long time much disputed, and various positions have been proposed; for a history of the subject I must refer those interested to the researches of Von Ihering,[1] Broca,[2] and Schmidt,[3] as it is too long to enter on here. The horizontal position most generally adopted by anthropologists is the condylo-alveolar plane, which has been shown by Broca to approach nearer than any other to that of the axis of vision when this is horizontally directed. A cranium can very easily be placed with the condylo-alveolar plane horizontal by means of Broca's craniostat or Topinard's very simple craniophore. Photographs or drawings of skulls in this position are very readily and accurately compared. Von Ihering,[4] Schmidt,[5] and Spengel[6] in their respective papers, have advocated the superiority of the audito-orbital plane. My own independent observations show me that in some instances this plane is directed more or less obliquely downwards instead of being horizontal; the same objection has been found to that of Von Baer by Broca. A decided objection to the adoption of the Frankfort plane in preference to the condylo-alveolar, even granting that the merits of the two are equal, is that it is more difficult to place the skull in the former than in the latter plane, and a more complicated apparatus is required. Above all things in anthropological research, simple and accurate instruments, easy of application, are desiderate objects, which, I regret to say, Germans do not always keep in view. As seen in a diagram, the audito-orbital, or so-called "German" horizontal plane, is a very precise and excellent one, but this may be said for several others which have been proposed at various times. The apparatus in which the skull has to be suspended, in order to place it in this plane (a frame such as that figured by Schmidt[7]), is a considerable obstacle in making a geometrical diagram of it with Broca's *stereograph*, or the *diagraph* of Garard, which are perhaps the most effective and simplest instruments for obtaining exact geometrical tracings. It is true that the skull could be placed loosely on the craniostat, adjusted to the audito-orbital plane with the frame, then fixed on the craniostat by means of its screw, and finally the frame removed. Such a procedure would, however, be difficult, owing to the care necessary in adjusting the skull, as well as in keeping it in exact position during the process, and consequently errors would frequently occur.

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[1] "Arch. f. Anthrop.," Bd. v (1872).
[2] "Bull. Soc. d'Anthrop." (Paris, 1873).
[3] "Arch. f. Anthrop.," Bd. ix (1876).
[4] *Loc. cit.*
[5] *Loc. cit.*
[6] "Zeit. f. Ethnol.," Bd. ix (1877).
[7] "Arch. f. Anthrop.," Bd. ix, p. 34 (1876).

An object to which great importance is evidently attached in the Agreement is that several measurements of the skull shall be taken in relation to the horizontal plane. This idea is not a new one, having been advocated by Spengel[1] and by Schmidt,[2] but it has not been taken up by anthropologists generally. With all due deference and respect to the opinion of our brethren in Germany, and the anthropologists of world-wide repute who have signed the Agreement, I venture to say that the advantages of having such measurements are chiefly theoretical. They are only obtainable with any degree of accuracy by means of complicated and costly apparatus, suitable only for the laboratory, and not even then, by their own showing, except after repeated control-measurements. The form of the skull is quite as fully and accurately indicated by means of measurements from certain fixed anatomical points with a simple pair of sliding callipers, such as those excellent ones of Professor Flower, which combine all the advantages of the *compas glissière* and the *compas d'epaisseur* of Broca, as by those measurements made in relation to the horizontal plane. The very great advantage of the former measurements is that they can be easily and accurately made without the manipulative skill and practice necessary for making the latter with corresponding accuracy.

From what I have just stated, it naturally follows that I do not attach importance to the horizontal length (*gerade Länge*) of the skull, as I believe the maximum length expresses fully the length of the skull. The fact that the horizontal and maximum lengths are the same excepting unusually formed skulls is sufficient reason, I think, to render a third column of length, in tables of skull measurements, superfluous. As regards the maximum length, it will be observed that it is not stated whether this is measured in the median line, as is directed to be done by Broca, and which should always be followed. The intertuberal length, as defined, is extremely indefinite, but I presume it is that of Welcher, the great objection to which is that its anterior measuring point is very indefinite. The length of the cranium, excluding the glabella, can be much more accurately measured from the ophryon to the most prominent part of the occiput—the ophryo-occipital length of Flower and others.

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[1] *Loc. cit.*
[2] *Loc. cit.*

The auricular breadth of Virchow likewise wants definition, the upper border of the auditory meatus being on a rapidly sloping plane. If the points of measurement are situated where the auriculo-bregmatic lines cross the prolongation ridges backwards of the zygomatic arches, the measurement is a very good one, being what we know in England as the bi-auricular breadth, which differs from that of Broca by including instead of being *above* the zygomatic ridges.

The height (No. 6), as recommended to be taken, is an unsatisfactory measurement. The auxiliary height (No. 7), taken from the basion to the bregma, is the height-measurement adopted now by the great majority of anthropologists, and is one of the most certain measurements of the skull, on account of the precision of those two points. The ear-height and auxiliary ear-height must also be classed as unsatisfactory, since all measurements which require to be made indirectly, that is, by measuring to a point off the skull, but corresponding to a point on it, are very uncertain, being difficult to measure and as frequently inaccurate as they are correct.

The length of the basilar portion of the cranium (No. 11) recommended can only be measured accurately in skulls when the basilar suture is still open. It is, however, a rule in craniology to reject all skulls in which the basilar suture is open; yet we have here a measurement proposed from the basion to that suture which closes about the twenty-fifth year, and in the majority of skulls is so obliterated by about the thirtieth year as not to be discernible with accuracy. The best measurement of this portion of the cranium is undoubtedly that proposed by Broca, from the basion to the posterior edge of the vomer.[1]

The breadth of the base of the skull at the base and summits of the mastoid process (Nos. 13*a* and 136*b*) have ceased to be taken by several anthropologists, as not being satisfactory measurements, and in my opinion should not find a place in a list of only the more important cranial measurements.

The vertical transverse circumference (No. 16) is in reality only an arc, not being continued across the base of the cranium, and differs from that designated the supra-auricular or bregmatic arc (which passes from one auditory point over the bregma to the other) in being taken perpendicularly to the horizontal plane, and consequently is not so good a measurement as the bregmatic arc. It will be observed that unanimity does not exist even among the framers of the scheme as to this measurement, since in a note it is stated that "till now Virchow measures over the bregma." It is to be hoped that he will prevail on his colleagues to adopt his method.

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[1] "Revue d'Anthrop.," 2nd ser., vol. v, p. 584.

As the other measurements of the cranium defined in the Agreement, viz., the maximum breadth, minimum frontal breadth, basio-nasal length, length and breadth of the foramen magnum, and the horizontal circumference, are exactly the same as those of Broca used generally by anthropologists, I need not allude to them.

We now come to consider the facial measurements; the first of these is the facial breadth of Virchow (No. 17), which is known in Broca's list of craniometrical measurements as the maximum bi-maxillary breadth, a name indicating its real character much better than that of facial breadth. It is a very precise and excellent measurement, and I almost think might replace Broca's bi-malar breadth, which, though it yields good results in distinguishing races, is very difficult to measure, and uncertain.

Under the facial breadth of Von Hoelder two measurement are included, viz.: the bi-jugal breadth and a similar measurement on the under-surface of the jugal bone, which is more uncertain, and, as far as I can see, superfluous. The first measurements (No. 17*a*) should be retained under the name of bi-jugal breadth, by which it is universally known.

The height of the face and of its upper or middle portion (Nos. 19 and 20).—The total height of the face, as here defined, from the basion to the under border of the mandible, can rarely be ascertained, owing unfortunately to the mandible or the teeth being frequently absent. The height of the middle portion is more practicable, and is a very useful measurement, giving not only the height of the face from the alveolar point to the nasion, but also completing the facial triangle when taken in conjunction with the basio-nasial and alveolar lengths. I am bound to admit that the facial height of Broca, which is the distance from the alveolar point to the ophryon, is an unsatisfactory measurement, owing to the ophryon not being a definite enough point; though on theoretical grounds it may be a good measurement, the portion of the skull between the nasion and the ophryon being more a portion of the face than of the brain-case proper. In matters where precision are concerned, I think theoretical reasons must yield to practical, and on this ground I for one would be happy to accept the nasio-alveolar height as the height of the face. The measurement, including the mandible, I think, we must consider impracticable, though it might be measured whenever possible. Of the measurements of the orbit I regard the horizontal width and vertical height (Nos. 24 and 26) as uncertain and unnecessary: uncertain, because they cannot be taken with sufficient accuracy, or only from a geometrical projection of the skull on paper, and unnecessary since the maximum width and height give the information required. I am quite aware that it is desirable to estimate the angles at which the transverse axes of the eyes make with the median line, but I believe this could be more accurately measured by direct means than by measuring the angles of incidence of the horizontal and maximum width lines.

The length and breadth of the palate are somewhat similar to those recommended by Broca, but cannot be considered satisfactory, firstly because it is very seldom that the palatal spine is perfect, and secondly because the spine does not represent the true length of the palate, being a bony prolongation beyond its posterior border. Some years ago Professor Flower[1] proposed a method which I believe to be preferable to that of Broca's, viz.: the length of the palate, from the alveolar point to the line of the posterior tuberosities of the maxillæ, measured in the mesial line; the breadth, that between the external lamellæ of the maxillary bones opposite the second molar tooth. These measurements, which can be ascertained with ease and precision, he has termed the maxillary length and breadth. The posterior palatal breadth does not seem to me to be of such importance as to warrant its insertion in such a table of measurements as that under review.

The length of profile of the face of Kollmann (No. 30) is the same as the basio-aveolar length of Flower,[2] and is a most valuable measurement. The name applied to it is, however, inferior to that of "basio-alveolar length," which is much more expressive. The profile angle (No. 31) is extremely ill-defined, but from the diagram appended (fig. 1, P*f*) I conclude it is the profile angle of Von Ihering,[3] which is the angle which a line passing from the nasion to the alveolar point makes with the horizontal line. Such an angle cannot be directly and accurately measured on the skull, but only on a drawing or diagram; consequently it is very objectionable, and should not be adopted. This angle, moreover, does not represent the true profile of the face if the previous measurement, No. 30, is considered, as it has been, the length of profile. The profile angle would logically be the angle at the alveolar point which the basio-alveolar line (No. 30) makes with the profile line, and which is undoubtedly the true profile angle.

The method of indicating prognathism or orthognathism which to my mind is the simplest, and at the same time very effective, is that of Professor Flower.[1] It consists of forming an index from the basio-nasial and basio-alveolar measurements, the former being taken as 100; the formula is therefore $\frac{100 \times \text{basio-alveolar length}}{\text{basio-nasial length}}$. When the index is below 100, as in most Europeans, the face is straight or orthognathous, but when over that number, as in most negroes, it is more or less prognathous. This index has been divided by Flower into three classes:—

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[1] "Journ. Anthrop. Inst.," vol. x, p. 161 (1880).

[2] "Proc. of the Royal Inst. of Great Britain," 1878.

[3] "Arch. f. Anthrop.," Bd. v (1872).

Orthognathous	below 98·0
Mesognathous	98·1 to 103·0
Prognathous..	above 103·0

The other measurements, namely, the bi-zygomatic and interorbital breadths, the length and breadth of the nose and of the orbit (Nos. 23 and 25), are the same as those defined by Broca in the "Instructions Craniologique," and usually adopted by anthropologists.

We have finally to examine the indices of the chief dimensions of the skull, and the classification proposed for them. The length-breadth, or cephalic index, is not properly defined, the length-measurement to be used in estimating it not being stated. The limits of the divisions into dolicho-, mesati-, and brachycephalic correspond exactly to those of Professor Flower,[2] but there is an additional group, the hyperbrachycephalic. The height index closely corresponds to Broca's divisions. The length measurement used in calculating this index is likewise not stated. The facial indices of Virchow are no indications of the facial breadth to its length, since the facial breadth used in the calculation of the indices is the superior bi-maxillary width, whereas the true breadth of the face is the bi-zygomatic width which has been adopted by Kollmann. The facial indices of Virchow might, it appears to me, be omitted from the list, and those of Kollmann, which are good indices, be retained. The orbital index differs from that of Broca and Flower in each of its three divisions, being two units lower than in the classification of these anthropologists. The nasal index is also one to two units lower than theirs, and has an additional division, that of hyperplatyrhine. The palatal index differs considerably, being no less than nearly ten units higher in the Frankfort classification than in Broca's, but it is stated the classification of this index is not definitely settled yet, as well as those of the length and breadth of the face.

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[1] **Osteological Catalogue of the Museum of the Royal College of Surgeons (1879), Part I, p. 251; and "Journ. Anthrop. Inst.," 120 (1879).**

[2] ***Loc. cit.***

In connection with the nomenclature of the different indices, certain distinctive and technical terms have been introduced in addition to those already in use, which will prove useful in describing the form of different parts of the face especially. Why similar terms invented by Broca, and now universally applied to certain points from which measurements are made—such, for example, as "basion," "ophryon," and several others—are entirely discarded for roundabout descriptions and definitions of the points, is not easy to understand, as by their use clearer ideas are conveyed as to points of measurement. It is also to be regretted that anthropologists in Germany have separated themselves from those in the rest of the world, by not adopting the same limits in the classification of indices derived from measurements universally used, such as those of the orbit and nose, the result of which will only be to cause confusion and detract from the value of certain convenient terms. We trust that when the limits of those indices, which are not yet definitely fixed, are finally arranged, due regard will be paid to the classification of those adopted by other anthropologists as well as those in Germany.

CONCLUSION.

After a careful study of the Frankfort Code of Measurements I think that it will be generally felt by anthropologists that while in some respects it is a step towards the unification of the methods of research in physical anthropology, which will be hailed with satisfaction, yet in others it is extremely unsatisfactory. It is satisfactory that the importance of the following measurements (numbered the same as in the text of the Agreement) has been recognised, and the method of making them is now agreed upon generally:—

2. Maximum length.
4. Maximum breadth.
5. Minimum frontal breadth.
7. Height (basio-bregmatic).
10. Basio-nasial length.
12. Length[1] ⎫ of foramen
13. Breadth ⎭ magnum.
14. Horizontal circumference.
15. Fronto-occipital arc.
17*a*. Bi-jugal breadth.
18. Bi-zygomatic breadth.
18*a*. Inter-orbital breadth.
21. Height of nose.
22. Breadth of nose.
23. Orbital breadth.
25. Orbital height.
30. Basio-alveolar length.

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[1] This measurement should certainly be added in the short table of "Principal Measurements," as without it the total sagittal circumference of the brain-case cannot be estimated.

The unsatisfactory portion of the Agreement is, that we must refuse to accept the following measurements proposed in it:—

1. Horizontal length.
6. Total height.
8. Ear-height.
9. Auxiliary ear-height.
11. Basilar length.
13*a*. Bi-mastoid width.
13*b*. Breadth of base of skull.
16. Transverse vertical arc.
17*b*. Infrajugal facial breadth.
24. Maximum horizontal orbital breadth.
26. Vertical height of orbits.
27. Palatal length.
28. Palatal breadth.
29. Posterior palatine breadth.
31. Profile angle.

Some of these are not accepted, owing to the points on the skull between which they are made not being satisfactory, and there is reason to hope that an understanding might be come to regarding them. The case is not so hopeful regarding others, which would appear from the text to involve the fundamental principles of the whole "Agreement"—I refer to the system of measuring the skull in relation to the Frankfort horizontal plane, to which we cannot assent, and which we would fain hope to see abandoned by our brethren in Germany for the more practical method adopted by the majority of anthropologists elsewhere.

Description of Plates VIII and IX.

Four Diagrams illustrating some of the cranial measurements recommended by the Frankfort Conference. Reproduced from the "Archiv für Anthropologie" by the courtesy of the German Anthropological Society, through Professor J. Ranke, of Munich.

DISCUSSION.

Professor **Struthers**, of Aberdeen, expressed his concurrence with the views of Dr. Garson. As one who had been long engaged in anatomical teaching, he felt the new interest which had been given to the study of the anatomy of these parts by regarding them from the anthropological point of view, as well as the interest which had been given to anthropology by importing into it anatomical considerations. He went on to say that it seemed to him that much might be done to explain the forms of skulls by considering the functions of their several parts, especially the influence exerted by the muscles of the jaw, and suggested this as an inquiry worthy of the attention of some of the younger anatomists who had time to pursue it.

Professor **Thane** observed that the meeting was greatly indebted to Dr. Garson for the trouble he had taken in bringing this code before the Institute, for the full and clear account he had given of it, and for the criticism to which he had subjected it. With the

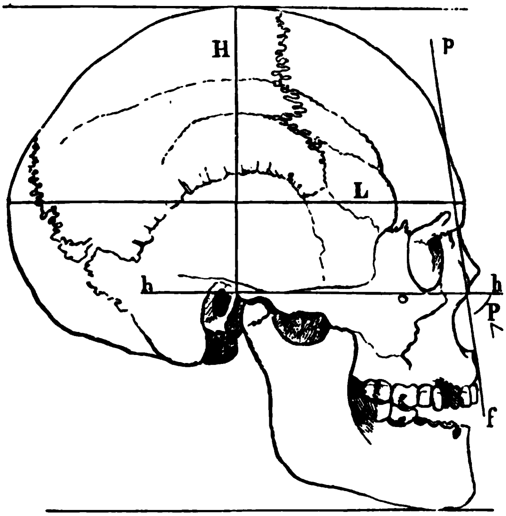

Fig. 1.

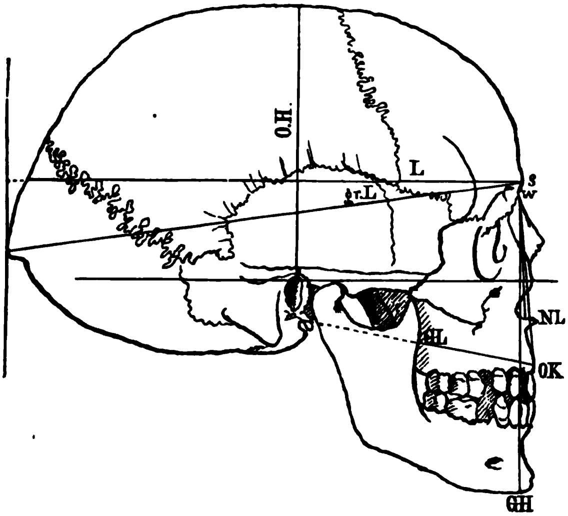

Fig. 2.

DIAGRAMS ILLUSTRATING CRANIAL MEASUREMENTS.

Journ. Anthrop. Inst., Vol. XIV, Pl. IX.

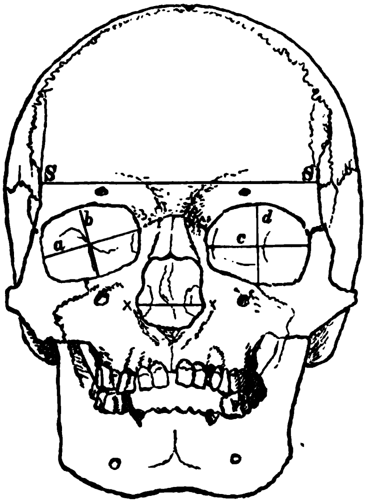

FIG. 3.

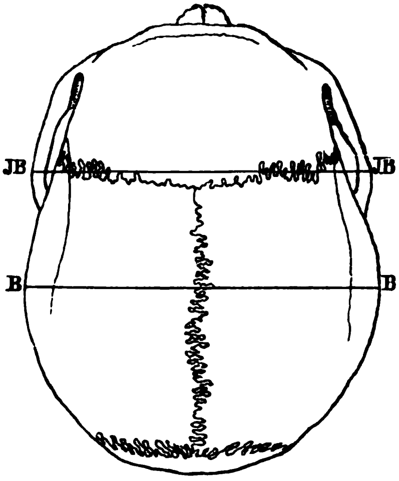

FIG. 4.

DIAGRAMS ILLUSTRATING CRANIAL MEASUREMENTS.

main features of that criticism the speaker entirely agreed. The names of those by whom the code had been prepared, and the list of those by whom the system had already been accepted, including most, if not all, of the eminent anatomists in Germany, who were working with so much zest and success in this branch of anthropology, must claim for it a most respectful consideration; and, moreover, it must be remembered that we had not before us a complete series of craniometrical instructions adapted for the guidance of beginners or of foreigners who could not be expected to be acquainted with the numerous and prolonged discussions of which the code is the outcome, and therefore the impressions which the study of the code alone had made upon us might be subject to modification in the light of further information. Additional information was especially to be desired as to the precise method of taking some of the measurements and the instruments which were employed, as to the objects of others, and as to the grounds upon which the selection of many of them was based. The principle upon which the chief dimensions of the cranium and the degree of projection of the facial portion of the skull were estimated was, however, obvious. An attempt was made to ascertain the horizontal and vertical extent of the skull while in its natural position, as it was carried during life. To this proceeding there were many objections, both to the principle itself and to the method of carrying it into practice. Whichever of the many that had been suggested be selected as the horizontal plane of the skull, the position must be an artificial one, for it was well known that all these planes varied more or less in different individuals in their relation to the true horizontal of the head, the visual axis. In this system the principal length of the cranium was in some cases not a direct measurement of the skull at all, but only a statement of its antero-posterior projection in a conventional position. To calculate indices from this dimension was misleading, since the relation of the height and breadth to the actual length of the skull was not thereby indicated; and at the same time it became extremely difficult, if not impossible, to compare results obtained from the measurement of skulls with observations on living persons. The remarks in the code itself, as to the close agreement between the vertical height and the basio-bregmatic height were a strong argument for preferring the latter, which was taken easily and directly between well-defined anatomical points, to a measurement that could only be taken indirectly, with difficulty, and with considerable liability to error. The system, in fact, strove after a mathematical accuracy which was unattainable in dealing with objects that showed so much individual variation, and in the effort to obtain this a violence was done to nature that, in the speaker's opinion, far outweighed the theroetical advantages of the plan. With regard to the horizontal that had been chosen, the "German horizontal plane," apart from the circumstance that the skull when placed as directed was in many cases obviously not in its natural position, laboured under the disadvantage that the tranverse lines joining respectively the highest points of the ear-openings and the lower margins of the orbital apertures were frequently enough not parallel, so that the so-called horizontal lines necessarily differed on the two sides of the head, and could not be brought into one plane. The individual measurements had been so fully discussed by Dr. Garson that further remarks upon them would be superfluous, and Professor Thane only expressed his feeling that it was greatly to be regretted that the French system, that was now meeting with such wide acceptance in other countries than Germany, appeared to be entirely ignored, and that even the convenient terms introduced by Broca for the various important craniometrical points and regions were not made use of.

The PRESIDENT also took part in the discussion, and the AUTHOR replied.

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